Doctoral dissertation summary

The influence of terrain transformations caused by bituminous coal mining on forest exposure to selected harmful factors on the example of the Rybnik Forest District forests

Mining settlements are one of bituminous coal mining forms that have a destructive influence on the number of forest stands in Rybnik Forest District. They cause changes in water condition, which in turn lead to increased creation of declining trees, as well as significantly greater number of uprooted trees. The weakening or damage to trees create favourable conditions for occupancy by cambio- and xylophagous insects and increase in populations of economically harmful species.

The lack of research concerning the size of negative results occurring in forests on territories of mining settlement, as well as the initial observations conducted in the forest stands of Rybnik Forest District has allowed to make the following research hypotheses: (1) the resistance of forest stands to sudden winds or snowcap decreases on mining terrains in relation to soil subsidence and water condition, which in turn contributes to the increase in uprooted trees; (2) mining settlements influence the increase in declining trees removed under casual thining through disruption of water condition; (3) the distribution of cambio- and xylophagous insect species inhabiting trees on mining terrains is more varied than on comparison terrains; (4) weakened and uprooted trees inhabited by cambio- and xylophage insects in forest stands growing on mining terrains are significant economically and have higher insects occupancy frequency and intensity.

The adopted hypotheses allowed to determine goals, which enabled their verification: (1) determination of the dynamics of declining and uprooted trees acquiring in forest stands on mining terrains depending on species, age and habitat of a tree, soil subsidence degree, and comparison with forest stands located outside of mining terrains; (2) determination of quantitative indexes for declining and uprooted trees in their participation in total volume and percent approach, in reference to forest stand reserves and abundance, and intensity of their acquisition on mining surfaces depending on the soil subsidence degree for both surface groups; (3) determination of insect species distribution for declining and uprooted trees, intensity of their presence, similarity of cambio- and xylophage groups and frequency indexes for a given species, occupancy intensity, commonality coefficients, and frequency similarities for both surface groups.

The terrain research was conducted in years 1997-2003 on the Rybnik Forest District forest stands on 80 surfaces (selected areas) subject to mining settlements and 80 comparison surfaces, which represented forest stands on various habitats and of various age. The declining

and uprooted trees on research surfaces acquired under casual thinings were subjected to entomological analysis. Specific trees were qualified to one of the following groups: insects occupied with active feeding areas, occupied with feeding areas abandoned by insects, and without signs of occupying by cambio- and xylophagous insects.

The total volume of acquired declining and uprooted trees of specific tree species was matched separately for each surface while taking into account the species of a tree, forest stand age, habitat, and soil subsidence degree in case of mining surfaces. Then the reaction of trees to change of conditions related to soil subsidence on mining surfaces in reference to comparison surfaces by using appropriate indexes had been determined.

Declining and uprooted trees were subjected to entomological analysis of cambio- and xylophagous insect occurrence. The occupancy of trees by specific insect species was examined in three sections of tree: trunk, crown base (conifer trees) or in the middle of crown (deciduous trees), and branch in middle crown part. The frequency of specific insect species and occupancy density were determined in these sections.

The research has indicated that uprooted trees acquired on mining surfaces in years 1997-2003 constituted as 1.0% of forest stand reserve and 2.10 m^3/ha on surface unit while on comparison surfaces those values were 0.4% and 1.05 m^3/ha respectively. The majority of uprooted trees on both surface groups was unoccupied and constituted as 69.9% the total volume of uprooted trees on mining surfaces while on comparison surfaces the value was 81.6%. The influence of forest stand age on annual average intensity of uprooted trees concerned mainly the oldest age classes, where the abundance of pines, birches, and beeches on mining surfaces were 0.2%, 0.9%, and 0.2% respectively and 0.06%, 0.07%, and 0.06% on comparison surfaces. The intensity of uprooted trees secretion on mining surfaces was significantly higher on fresh forest and fresh mixed coniferous forest at level of 2.8% and 0.4% abundance at 0.5% and 0.09% abundance on comparison surfaces. Trees uprooted were especially intensively present in 1^{st}, 5^{th}, and 4^{th} degree of soil subsidence, where they achieved 0.9%, 0.9%, and 0.8% species abundance respectively. Thus, the hypothesis about the forest stands resistance to sudden winds or snowcap decreases in relation to soil subsidence and water condition on mining terrains, which in turn contributes to the increase in uprooted trees was confirmed.

It has been shown that uprooted trees on mining surfaces constituted as 3.0% of forest stand reserve and 6.54 m^3/ha on surface unit while on comparison surfaces those values were 0.6% and 1.50 m^3/ha respectively. The majority of both surface groups were registered as unoccupied uprooted trees, which constituted as 39.2% the total volume of uprooted trees on mining surfaces while on comparison surfaces the value was 49.3%. The general annual average increase in uprooted trees secretion for main species – pine, spruce, and oak was significantly

greater on mining settlement surfaces, where it achieved 2.1%, 0.04%, and 0.8% abundance at 1.2%, 0.4%, and 0.3% abundance on comparison surfaces. In terms of age, the annual average increase in uprooted trees secretion mostly concerned the 3rd class forest stand age, where on mining surfaces it achieved 8.5% for spruce, 1.8% for pine, and 0.6% for birch species abundance, while the same values were respectively 2.2% for spruce, 0.03% for pine, and 0.0% for birch on comparison surfaces. The uprooted trees secretion on mining surfaces was significantly higher on fresh forest and fresh mixed coniferous forest at level of 2.0% and 2.5% abundance at 0.1% and 0.5% abundance on comparison surfaces. Uprooted trees were especially intensively present in 9th, 11th, 6th, and 5th degree of soil subsidence, where they achieved 3.4%, 2.8%, 2.8%, and 2.4% species abundance respectively. Therefore, the hypothesis about mining settlements influencing the increase in declining trees removed under casual thining through disruption of water condition was confirmed.

It has been found that more numerous cambio- and xylophagous groups of insects occurred among declining and uprooted trees present on mining surfaces. 91 species were found on mining surfaces and 62 species on comparison ones. By average, over 15 species were present on mining surfaces, while on comparison surfaces there were over 5 species of insects. The number of mutual species amounted to over 2. When comparing species variation sizes for surface groups, the average similarity indexes J (0.1146), J` (0.0889), and Ku (22,4305) for species and frequency indicated that statistically there were few species similar to each other. The indexes also certify about decreased number of species on comparison surfaces and that mining and comparison surfaces belonged to different environments in terms of entomology. Only 5 pairs of examined surfaces had Ku index of >60.0%, which confirms that those pairs belonged to the same community. As a result, the hypothesis about the distribution of cambio- and xylophagous insect species occupying trees on mining terrains is more varied than distribution on comparison terrains was confirmed.

Cambio- and xylophagous insect species groups were distinguished on spruce, pine, birch, oak, and beech trees as a characteristic for main forest tree species. The lead representatives of economically important insect groups present on main forest tree species on mining surfaces found more favourable conditions to accommodate and multiply their population. The following species achieved a higher accommodation frequency and intensity on spruce trees from mining surfaces than on comparison surfaces: *Ips typographus*, *Ips amitinus*, *Ips duplicatus*, and *Trypodendron lineatum*. The following species achieved a higher accommodation frequency and intensity on pine trees from mining surfaces when compared to comparison surfaces: *Ips acuminatus*, *Tomicus minor*, *Tomicus piniperda*, *Pityogenes bidentatus*, *Pissodes pini*, *Pissodes piniphilus*, and *Pityogenes quadridens.* A higher accommodation frequency and

intensity on birch trees from mining surfaces when compared to comparison surfaces was achieved only by *Scolytus ratzeburgii*. The following species achieved a higher accommodation frequency and intensity on oak trees from mining surfaces when compared to comparison surfaces: *Scolytus intricatus, Agrilus sulcicollis, Agrilus biguttatus*, *Plagionotus arcuatus arcuatus*, and *Rhagium mordax.* The following species achieved a higher accommodation frequency and intensity on beech trees from mining surfaces when compared to comparison surfaces: *Agrilus viridis viridis*, *Xyleborus monographus*, *Rhagium mordax*, *Trypodendron domesticum*, *Taphrorychus bicolor*, *Leiopus nebulosus nebulosus*, and *Elateroides dermestoides.* Therefore, the hypothesis about weakened and uprooted trees occupies by cambio- and xylophagous insects in forest stands growing on mining terrains are economically significant and have higher occupancy frequency and intensity was confirmed.

In summary, cambio- and xylophagous species on mining surfaces found more favourable trophic conditions and numerously shown high flexibility in selection of accommodated trees, as well as adoption to specific environment conditions on mining subsidence terrains.

Communities of mining terrains and comparison terrains are not uniform and have small resemblance in terms of entomology. This factor was decided on mining surfaces by declining trees remaining for partially longer time and not removed uprooted trees, which is often related to terrain inaccessibility.